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UK Patent Application (19) GB (11) 2 078 166 A

- (21) Application No 8019596
- (22) Date of filing 16 Jun 1980
- (43) Application published
8 Jan 1982
- (51) INT CL³
B32B17/10 // 27/06
27/36
- (52) Domestic classification
B5N 1710 2706 2736
- (56) Documents cited
 - GB 1558503
 - GB 1389046
 - GB 1306313
 - GB 978844
- (58) Field of search
B5N
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(54) Composite sheets

(57) Composite sheet material is built-up of a plurality of single plates joined together by means of one or more interposed biadhesive tapes. The composite sheet may be provided with a coloured or reflecting film and may comprise in addition inserts formed of films or wires provided for increasing the strength of the sheet or for serving as parts of electric heating or alarm circuits. The process for

making the sheets provides for the application of the biadhesive tapes without the forming of air pockets and for a compression effect acting over the whole surface of the composite sheet within an autoclave. The single plates forming the sheet may be of glass, polycarbonate, or other synthetic material. The biadhesive tape is preferably provided on both sides with a protective film, to be removed before the application of the tape and the adhesive securement together of the single plates.

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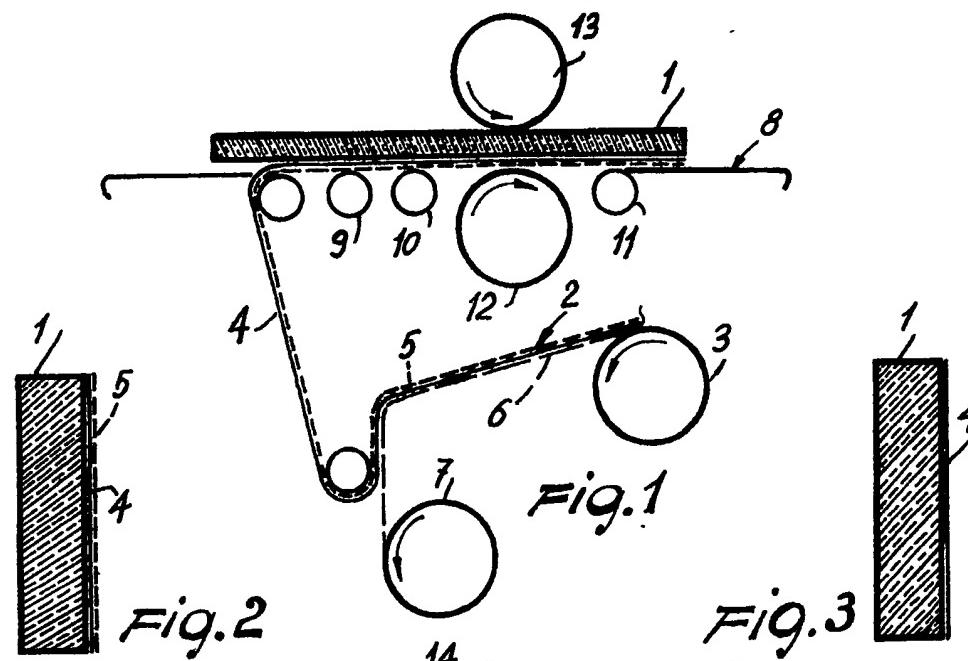


Fig. 2

Fig. 1

Fig. 3

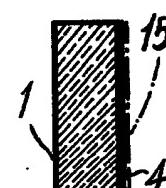


Fig. 4

Fig. 5

Fig. 6

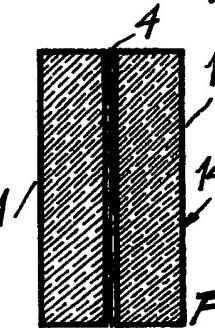


Fig. 7

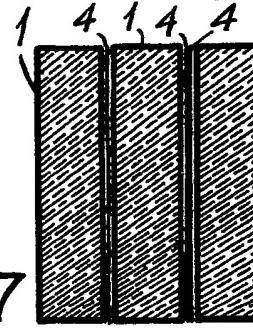


Fig. 8

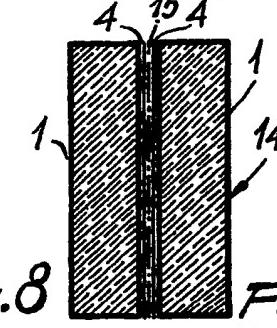


Fig. 9

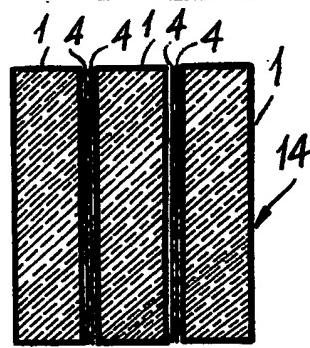


Fig. 10

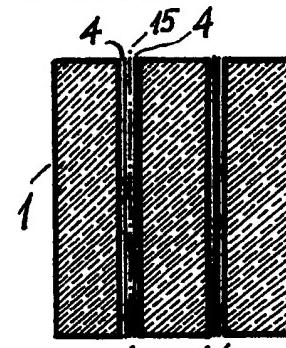


Fig. 11

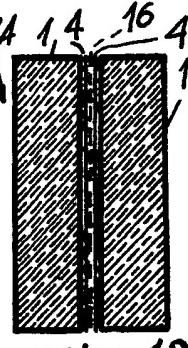


Fig. 12

SPECIFICATION
Composite sheets

This invention relates to composite material and to a process of making such material.

5 The composite sheet material of the invention can comprise, for example, bullet-proof safety glass such as is used in armoured cars and trucks, and in banks, jeweler's shops and the like.

Safety glass sheets are already known to the 10 art which are not bullet proof and which consist of glass sheets incorporating some netting or formed of glass having a thickness only of the order of a few centimeters.

However, these sheets are not fully capable of 15 resisting the impact of heavier firearm bullets, particularly when hit more than once.

There are known, in addition, composite sheets 20 in which an adhesive liquid or viscous means is interposed between two glass sheets to act as means for joining the two sheets. The making of such composite sheets is rather difficult and the known methods are not suitable for the making of large size sheets on an industrial scale, it being very difficult to prevent the formation of air bells or 25 pockets between the single sheets to be joined. In addition, the known adhesives tend to be degradable when exposed to the effects of light, ultraviolet rays and the like so that, after a certain time, separation of the glass sheets tends to 30 occur.

A further disadvantage of the known composite sheets is the fact that the adhesive chosen, for example, for the joining of glass sheets does not allow a solid joint between plastics sheets, for 35 example, sheets of methacrylate resin and, on the other hand, adhesives appropriate to plastics materials do not ensure a solid joint of the latter with glass sheets.

It is also known to interpose, between the 40 single sheets of a composite plate, layers of adhesives for example rubber, or polyvinylbutyral plastics or epoxypolyester resins with methacrylate resins or other types of resins prepared and catalyzed before the application 45 phase and spread on the single sheets to be adhered before joining them. It is also known to pour the plastics materials between the glass plates or between a glass plate and a polycarbonate plate and then to compress the 50 sandwich type composite sheet.

As already mentioned before, it is very difficult to avoid the formation of air bubbles or bells, in particular when making large size sheets. Another disadvantage is the impossibility of using 55 polyvinylbutyral for the joining of polycarbonate sheets, while, when using liquid plastic materials, distortions result and the strength of the composite sheet is rather uncertain.

A disadvantage of single-piece safety sheets 60 arises from the possibility that glass chips caused by breakage will injure people near the sheet, for example, in cars and other vehicles.

The invention accordingly provides a composite sheet comprising two or more plastics adhesively

65 secured together by biadhesive sheet material.

The invention also provides a method of making a composite sheet comprising the steps of applying to one side of a first plate a biadhesive sheet and applying a second plate to the exposed side of the biadhesive sheet.

The biadhesive tape used in accordance with the invention comprises a film-like support having an adhesive layer on each side.

The invention thus provides a composite safety sheet consisting of, indifferently, glass sheets only, or of plastics, for example, polycarbonate, sheets only or of mixed sheets. The invention further provides for the making of such composite sheets on an industrial scale, at a high production speed, without any limits in size, and with a flawless product, that is, in particular, one without the formation of air bubbles and bells.

It is in addition very easy to colour the sheets of the invention in a simple and quick manner, advantageously at low cost and without having to make use of colouring baths.

It is moreover readily possible in accordance with the invention to incorporate within the composite sheets, graphical inserts, words or symbols, as is of interest in particular in the case of sheets for use as panes in shops, banks, and the like.

The invention is further described below, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic side view of a plant for making glass sheets to be used to make composite sheets in accordance with this invention;

Figs. 2 to 4 are vertical cross-sections through sheets made with the plant shown in Fig. 1; and

Figs. 4 to 12 are vertical cross-sections through respective different forms of composite sheets according to the invention.

In the plant shown in Figure 1, there is applied to a glass plate 1 a biadhesive tape 2 in accordance with this invention. The tape 2 is wound on a reel 3 and consists preferably, as in the case here shown, of a biadhesive sheet 4 covered on both sides with respective protective films 5 and 6. For purposes of clarity, the drawings are not to scale but are partially oversized to facilitate the understanding of the invention. A reel 7 is provided for winding up of protective film 6 before making the biadhesive tape 4 adhere with its free adhesive side to the lower face of the plate 1. The latter is running on a working table 8 advantageously comprising feed and support rollers 9, 10 and 11. By 12 and 13 there are indicated respectively a lower and an upper entraining roll ensuring the safe application of the tape 4 without the formation of air pockets or bubbles. After the application of the biadhesive tape 4, preferably still provided with the outer protective film 5, the plate 1 is as schematically indicated in Fig. 2. At this stage we thus have a glass plate, or a plate of polycarbonate or other plastics material which can be either stored or immediately used for the making of a composite

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- safety, bullet-proof or other sheet 14 as outlined in detail below.
- It must be noted that at this stage of the process, the plate 1 can receive, after a removal of the protective film 5, a thin coloured sheet or film 15, as shown in Fig. 4, giving in this manner a uniform and extremely cheap coloration of the plate 1. The film 15 may consist instead of a reflecting material, permitting the making of mirrors or of composite sheets, allowing visibility only in one direction or a better visibility in one direction than in the other.
- The composite safety or bullet-proof sheets 14 may comprise two single plates 1 joined by one or two biadhesive tapes 4 as shown in Figs. 5, 6, 7. The choice depends upon the thickness of the available tape. For very thin tapes, for example 0.127 mm, it is advisable to use two tapes 4 for compensating in a reliable manner for possible defects in the flatness of the sheets 1, while thicknesses for example of 0.2 to 0.4 mm may be sufficient to allow the use of one tape only. It will be necessary to use two tapes 4 when it is desired to provide inserts between the sheets as described below. Figs. 8 and 10 show safety or bullet-proof sheets 14 built up of three plates 1 with either single or double biadhesive tapes 4.
- In Fig. 12, for example, 16 indicates an insert, for example a mesh or net of metal or of synthetic fibre, for the purpose of increasing the strength of the composite sheet. Such an insert can instead be made of wires again for the purpose of increasing the strength of the sheet and/or for acting as electrical conductors for use of the sheet in electric alarm or heating systems and the like.
- Although reference is made herein to glass plates 1, it is to be understood that the single plates for forming the composite sheets of the invention may be glass, or polycarbonate, or any other synthetic material; this applies also to the other forms of sheet, for example that shown in Fig. 5.
- In all the composite sheets 14 shown, the starting stage is that of a single plate with the biadhesive tape 4 applied to one side thereof as shown in Fig. 2 or to both sides with the possible interposition of coloured or reflecting sheets 15 or other inserts 16 according to the desired type of final composite sheet.
- As already mentioned, the biadhesive tape permits the flawless jointing of glass plates, polycarbonate plates, or plates of other plastics material, either with a like plate or with one of the others.
- In the process according to this invention, after the lining of plate 1 with a biadhesive tape 4 and after the joining of the different plates with or without inserts to form the composite sheet 14, the latter is finished by feeding it into an autoclave and applying a high pressure at the required temperature. This autoclave phase ensures a uniform pressure effect over the whole surface of the sheet.
- Good results have been obtained by applying a pressure of the order of 12 kg/sq. cm at a
- temperature of about 130°C for a treatment time of about 3—5 hours, according to the materials to be treated. It is best to use an atmosphere of a low degree of humidity. If the single sheets have curved surfaces, for example for bowed windshields for cars, and one of the composite plates is polycarbonate, the latter will already have applied thereto the adhesive tape together with its outside film before the bowing phase.
- The tape 4 film may for example be an acrylic adhesive Scotch Transfer tape type 918 as produced by the American firm 3M, having a thickness of 0.127 mm.
- The above given description will be understood to indicate the possibility of achieving, by use of the composite sheets and the method for their manufacture, in accordance with the invention, as outlined above, the achievement in a highly efficient way of an improved and advantageous composite sheet.
- In particular, it is possible to obtain composite safety, that is, bullet-proof, sheets of a high strength, which present no danger of chipping even if hit several times by bullets, which can be made in a simple and quick manner, which reliably excludes the formation of air bells. A fundamental point of this invention is the presence of a biadhesive tape, which may or may not be provided with an internal sheet-like support. The two adhesives may be of the same type or different, and the biadhesive sheet may have no protective film or a protective film on one side only or on both sides thereof. The biadhesive tape may have a width preferably equal to or larger than the width of the composite sheet to be built up. Inserts used may bear legends or drawings, for example trade marks or the like, to be used for example in glass panes for windows and doors of banks, shops or the like.
- The process of this invention as well as the adhesive means proposed herein, allow composite safety and bullet-proof sheets to be obtained which are perfectly flawless, and which may be coloured or provided with specific inserts, while preventing completely the forming of air bells and any degradability of the liquid adhesive means as encountered in the present state of the art.
- The materials for the protective films may for example be polyethylene, polyesters, siliconized paper and the like.
- In practice, these materials as well as the chosen adhesives and the eventual film-like support of the latter which, as such, may be coloured, and also the material for the single plates may be freely chosen without departing thereby from the scope of this invention.
- CLAIMS**
1. A composite sheet comprising two or more plastics adhesively secured together by biadhesive sheet material.
2. A composite sheet as claimed in claim 1 wherein the plates are of like material.
3. A composite sheet as claimed in claim 1 or 2 wherein at least one of the plates is glass,

- polycarbonate or other plastics material.
4. A composite sheet as claimed in claim 1, 2 or 3 in which at least one of the plates is of plastics material and is coloured.
- 5 5. A composite sheet as claimed in claim 1, 2, 3 or 4 wherein two plates are secured together by a single biadhesive sheet only.
6. A composite sheet as claimed in claim 1, 2, 3 or 4 wherein two plates are secured together by
- 10 two biadhesive sheets, each sheet adhering at one side to a respective one of the plates and at the other side to the other biadhesive sheet.
7. A composite sheet as claimed in any preceding claim having an insert between two
- 15 plates.
8. A composite sheet as claimed in any one of claims 1 to 7 wherein two plates and an insert therebetween are secured together by two biadhesive sheets each located between a
- 20 respective plate and one side of the insert.
9. A composite sheet as claimed in claim 7 or 8 wherein the insert is sheet-like.
10. A composite sheet as claimed in claim 9 wherein the insert comprises a film which is
- 25 coloured and/or carries drawings, decorations, words or the like.
11. A composite sheet as claimed in claim 9 wherein the insert consists of a film capable of reflecting the sun's rays.
- 30 12. A composite sheet as claimed in claim 7 or 8 wherein the insert is formed of wires capable of connection into an electrical heating circuit an alarm circuit or the like.
13. A composite sheet as claimed in claim 7 or
- 35 8 wherein the insert is of metal or synthetic material.
14. A composite sheet as claimed in any preceding claim provided with an outer film.
15. A composite sheet as claimed in claim 14
- 40 wherein the outer film is coloured, ornamental, reflecting, or comprises an electric conductor.
16. A composite sheet substantially as herein described with reference to any one of Figs. 2 to 12 of the accompanying drawing.
- 45 17. A method of making a composite sheet comprising the steps of applying to one side of a first plate a biadhesive sheet and applying a second plate to the exposed side of the biadhesive
- sheet.
- 50 18. A method as claimed in claim 17 wherein the biadhesive sheet is protected by removable protective films, only one of which is removed initially for securing to one of the plates, such plate being ready for immediate use or for use at a later date.
19. A method as claimed in claim 17 or 18 comprising applying to an exposed side of one of the plates a further biadhesive sheet for the connection of a third plate.
- 60 20. A method as claimed in claim 17 or 19 comprising applying a uniform pressure at a high temperature uniformly applied over the whole surface of the composite sheet.
21. A method as claimed in claim 17 wherein the pressure is applied in an autoclave.
22. A method as claimed in any one of claims 17 to 21 wherein the application of the biadhesive tape to the plates is effected by calendering.
23. A method as claimed in any one of claims
- 70 17 to 22 comprising the prior step of cleaning a face of each of two plates.
24. A method as claimed in any one of claims 17 to 23 wherein the biadhesive means consists only of a thin layer of adhesive material without any film support.
25. A method as claimed in claim 24 wherein the adhesive layer is applied by rolling or spraying.
26. A method of making a composite sheet substantially as herein described with reference to
- 80 Fig. 1 of the accompanying drawing.
27. A biadhesive tape for the building up of composite sheets, the tape comprising a film-like support covered on each side with a thin adhesive layer.
28. A biadhesive tape as claimed in claim 27 wherein the tape consists of a biadhesive solid tape.
29. A biadhesive tape as claimed in claim 27 or 28 wherein the or each adhesive layer is covered
- 90 by a thin protective film.
30. A biadhesive tape as claimed in claim 26, 27 or 28 wherein the thin adhesive layers are of different adhesive material.
31. A biadhesive sheet substantially as herein
- 95 described with reference to the accompanying drawing.